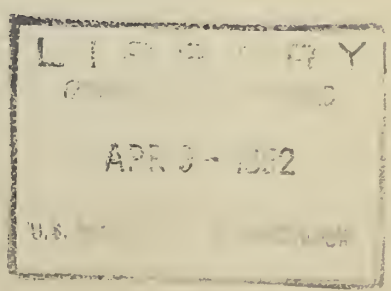
FOR HIGHER YIELDS OF CORN

Corn is our most important feed grain. It accounts for about 25 percent of all feed consumed, including pasture and roughage, and about 75 percent of the feed grains. In recent years more corn has been used than has been produced which has seriously reduced reserves. Higher yields per acre are the most practical way to meet increasing demands for this essential crop.

U. S. Department of Agriculture

PA 198 April 1952



FOR HIGHER YIELDS OF CORN

A hundred bushels of corn can be grown on an acre of good cropland in many areas of the United States nowadays. Literally thousands of cornfields are averaging that much per acre. In the Corn Belt, 200-bushel-an-acre yields are a popular topic of conversation and some farmers there have already reached that goal. Perhaps the most significant thing about the trend toward higher yields is the fact that they can be produced at greater net returns to the grower.

For 75 years prior to 1940, the average yield of corn in this country was around 26 bushels an acre. But for the past four years, the average yield has been about 39 bushels, largely because more and more farmers are using a combination of farming practices that produces higher yields. By combination we mean proper seedbed preparation, the correct use of more fertilizer, adapted hybrid seed corn, the right number of plants per acre, improved weed, insect, and disease control, efficient use of machinery, good crop rotations, and the best possible timing of all corn production operations. The best farmers are using several or all of these practices and are getting yields averaging twice as high as those for the country as a whole. Although all farmers are not likely to become eligible for membership in 100-bushel-an-acre corn clubs, agricultural experts believe that average corn yields in the United States can be doubled by wider use of currently known good farming practices. (The charts on page show some trends that are pertinent to corn production in the United States.)

Because the soil and other conditions vary so much from State to State, from farm to farm, and even from field to field, no standard formula can be given to fit all farms. In recent years, however, several of the State Agricultural Experiment Stations have conducted experiments which prove the merits of combining a number of good farming practices under given conditions. Much of the work has been conducted in cooperation with the U. S. Department of Agriculture.

CORN LIKES GOOD SOIL

The ideal soil to grow corn on is reasonably deep, has good drainage, a high capacity for absorbing and holding moisture, a generous supply of organic matter, and contains enough of the essential crop-producing nutrients, especially nitrogen. But a lot of land in this country does not have that kind of soil. Therefore, on land that lacks some or all of these qualities, the shortcomings have to be offset by fertilizers, legume crops, drainage, liming, erosion-control practices, or whatever else might be required to approach ideal crop-producing conditions.

Where the soil is too poor to respond to such treatment, it simply does not pay to go through the motions of trying to grow corn. How can you tell whether your soil is too poor? Soil-testing services are available to farmers in most States free of charge, or for a small fee. But it is important to remember that soil tests need local interpretation to be of real value in determining the amount of nitrogen, phosphate, or potash required for a particular cornfield. The crop rotation history and previous fertilizer applications on each field, for instance, might have a lot to do with the fertilizer mixture required to produce high yields of corn. At least 150 pounds of nitrogen, 50 pounds of phosphoric acid and 100 pounds of potash are required to produce 100 bushels of corn. A part of this may come from the soil, a part from the crop residues plowed under, and a part from commercial fertilizer. In many instances, experience has shown that high corn yields are produced without any commercial fertilizer on freshly plowed sod.

A GOOD SEEDBED GIVES CORN A GOOD START

A poorly prepared seedbed will not produce maximum yields. The best time to plow is when the soil is dry enough so that the upturned surface is loose--not cloddy or highly pulverized. Then use the right implements, usually the disc and spike-toothed harrow, to kill any newly sprouted weeds, to smooth the surface, and to pulverize the soil just enough so that the seed can be well covered with loose

soil--not clods or dust. The experts say that too many seedbeds are over-pulverized and over-packed.

The seed should be planted just deep enough to get it into moist soil. After a rain this might mean 1 to 1½ inches but after a week of dry weather it might mean 2 to 2½ inches. Seed that is just deep enough to be and remain in moist soil and to be protected from birds and rodents, will come up sooner and the plant will have just as deep a root system as though the seed were planted deeper. Unnecessarily deep planting is especially bad when the soil is cold.

The best time to plant varies a little according to the season and from one community to another. The best guide is to follow locally established planting dates, bearing in mind that if the seed germinates well and if the field can be kept free of weeds, corn planted early in the planting period often has important advantages over that planted later. It should also be borne in mind, however, that the advantage of early planting may be lost when delayed planting may be necessary to avoid such specific hazards as spring floods, cutworms, first-generation corn borers, and certain other insects.

MODERN CORN PRODUCTION CALLS FOR HYBRID SEED

Several hundred corn hybrids have been developed since the first hybrid was distributed to farmers about 20 years ago. Hybrids adapted to most of the corn growing regions of the country now are available. In selecting a hybrid for his own farm, the corn grower should consider these factors: How does it compare with other varieties with respect to yields; is it early enough to mature and late enough to produce a good crop; is it resistant to or tolerant of the more harmful diseases and insect pests in his own area; is it resistant to drought injury; what about the tendency of the ears to drop off or the stalks to break; and is the seed reasonably well graded and of good germination. Hybrid seed that rates good on all these points will give the grower the best return for his money.

MORE PLANTS PER ACRE MEAN MORE BUSHELS

No matter how rich the soil of a cornfield or how much fertilizer is put on it, top yields will not be produced from a thin stand. Experience on most Corn Belt soils indicate that in order to get maximum benefit from fertilizer there should be from 12,000 to 14,000 stalks per acre. In the South experiments show that 10,000 to 12,000 plants per acre is a good mark to shoot at. In 4-year tests at State College, Miss., with other production factors equal, increasing the number of plants from 4,000 to 12,000 per acre, increased the average yield from 68.8 to 105.5 bushels. In both cases 120 pounds of nitrogen were applied.

The important thing to remember is to balance the number of corn plants with the ability of the soil to produce. It is also advisable to plant from 10 to 20 percent more seed than is expected in the final stand to allow for such hazards as non-germination, bugs, cultivation, dry soil, and the like.

FERTILIZERS: HOW MUCH, WHEN, AND HOW TO APPLY

A great deal has been learned in recent years about the use of fertilizer on corn. Here again, no standard formula can be given due to the wide variations in soils, climate, and other local factors. All research up to now does indicate, however, that no corn grower should overlook the possibilities of profits that can come from using the right mixture of fertilizer, in the right amounts, at the right time and properly placed. The results of work at several State experiment stations are presented on other pages of this leaflet which show more specifically what effect fertilizer applications can have on corn yields.

NIP WEEDS IN THE BUD

Weeds use up moisture and fertility that ought to go into the corn plants. For maximum effect they should be killed off while still in the seedling stage or before they show above the ground. This can be done with wide implements designed

for shallow cultivation such as the spike tooth harrow, the weeder, and the rotary hoe. Once over before the corn comes up and one to three times right afterwards, depending on the weed condition, will usually do a good job of keeping weeds under control.

The ordinary corn cultivator is the implement most commonly used after the corn is four or five inches high. The shovels should be set only deep enough to destroy the weeds because deep cultivation, four inches or more, close to the corn plants is very damaging to them after they are past the seedling stage. The duck-foot type shovel with wide sweeps carried nearly horizontally is now widely used and recommended. If weeds have been kept under control and if the stand is heavy enough to provide normal shade, there is usually no point in cultivating corn after it is 2 to 2½ feet tall.

Under some conditions chemical weed killers have proven effective and are gaining in popularity. But they are a relatively new method of getting rid of weeds and should be used cautiously or only when and as recommended locally. In any event, chemical weeding should not be considered as a substitute for cultivation but rather as a supplement to it for controlling weeds in corn. In many cases where the soil is too wet to cultivate, 2,4-D may be used effectively to save the corn crop even though some temporary injury from the chemical might occur.

INSECTS CAN TAKE A TERRIFIC TOLL

The corn crop is subject to attack by approximately 25 different insects and failure to control them can easily mean the difference between success and failure. The European corn borer is of course enemy No. 1 but several others including corn earworms, corn root worms, chinch bugs, and grasshoppers also take a heavy toll in certain areas if proper measures are not taken to head them off. In 1951, when corn borer losses were the lowest they had been in five years, the toll added up to an estimated 36 million bushels valued at about 57½ million dollars. In some years

losses have been four and five times that much.

With respect to corn borer control the researchers recommend these four practices: (1) clean cultivation and other measures to get rid of stubble and other debris; (2) observe the most favorable planting dates; (3) plant strong, well-adapted hybrids; and (4) use insecticides where necessary. As to the best insecticides to use, DDT and ryania have given the most satisfactory results. The use of aircraft for spraying cornfields has been found less efficient than other methods but it is worth considering where applications from the ground are impractical. Specific instructions as to what, when, and how to use anti-corn borer insecticides should be obtained from your county agent or State Agricultural Experiment Station.

The corn earworm does some damage wherever corn is grown but is most destructive in the Southern States. The best way to prevent earworm damage in field corn is to grow hybrids with long heavy husks. Early planting also helps some in that it permits the corn to be well along before the earworm population becomes numerous.

Three different species of corn rootworm attack corn in this country; the Southern corn rootworm, the Northern corn rootworm, and the Western corn rootworm. The first two species can be kept under control fairly well by a crop rotation that allows two years between crops of corn on a particular field. Workers in several Corn Belt States have recently found that corn rootworms can be controlled by applying aldrin or chlordane to the soil prior to planting.

Although efforts have been made to control chinch bugs ever since the first general outbreak nearly 170 years ago, they are still an extremely harmful pest. Spraying and dusting with various insecticides have been tried but the only measures that have been found to be generally practical are: (1) To grow immune or resistant varieties of crops; (2) use locally recommended practices to prevent

infestation; and (3) use barrier traps to kill the bugs as they crawl from small grains to the cornfields.

In recent years aldrin, chlordane, and toxaphene have become the most widely recommended insecticides for the control of grasshoppers. They may be applied in dust, spray, or bait form but sprays give highest initial kills and continue to kill over the longest period. Dieldrin, dilan, heptachlor, lindane, methoxychlor, and parathion show promise for grasshopper control but these insecticides should not be used unless specifically recommended by State entomologists. But regardless of the methods used to control grasshoppers, the most effective procedure is for all property owners in a community to join together in destroying threatening infestations of these pests wherever they are found. They can travel many miles in a single day so it is less practical to attack them on a farm-to-farm basis. Detailed recommendations on grasshopper control can be obtained from your county agent or State experiment station.

Some Experiment Station Results:

In recent years some remarkable results have come from corn production research at State Agricultural Experiment Stations, much of which is conducted in cooperation with the U. S. Department of Agriculture. These results add up to the fact that the wide spread between average and potential yields of corn can be lessened. In view of the increasing demand for feed grains, the wider application of these research findings will not only benefit the Nation but will mean that more corn can be produced at a lower cost per bushel, with less soil deterioration, and with greater net returns to the grower.

Some results from various stations are presented below.

At State College, Mississippi:

One phase of a 4-year (1947-50) experiment at State College on Kaufman fine sandy loam brings out clearly the benefits of balancing the amount of fertilizer

used with the number of plants per acre. Four replicate tests were conducted with the same treatments superimposed on the same plots each year. Adequate phosphoric acid and potash were supplied in all treatments, but the amount of nitrogen and the number of plants per acre were varied. Here are the results:

Pounds of Nitrogen Per Acre	Plants Per Acre	Average Yields
0	4,000	29.4
60	4,000	64.8
120	4,000	68.7
0	12,000	35.0
60	12,000	75.2
120	12,000	105.5

Some other benefits indicated by the Mississippi Station research are these: (1) The dense and fast early growth of corn, as a result of more fertilizer and plants per acre, discourages grass and weeds permitting the crop to be laid by with one less cultivation: (2) the more highly fertilized corn has higher protein content; and (3) about three times as much crop residue is returned to the soil.

In reply to the question: Does it pay to apply these treatments to the soil?, the following figures from the Mississippi study are presented:

Pounds of nitrogen per acre -	0	60	120
Number of plants per acre -	4,000	8,000	12,000
Bushels per acre	22	52	72
Value of corn at $1.50 per bu.	$33.00	$78.00	108.00
Total production costs, including land rental, cost of equipment, seed, labor, and fertilizer	18.96	35.86	48.75
Returns to management	14.04	42.14	59.25
Production cost per bu.	0.86	0.69	0.68

Complete details on this study can be obtained by writing to the Mississippi Agricultural Experiment Station at State College, Mississippi.

AT NORTH CAROLINA'S AGRICULTURAL EXPERIMENT STATION:

Until about a decade ago, the average yield of corn in North Carolina was around 18 to 20 bushels an acre. Now, with advanced knowledge about adapted hybrids, the correct use of fertilizer, and more plants per acre, it is not considered economical to grow less than about 50 bushels of corn per acre.

Actual experiments conducted during 1944-48 by the North Carolina station at Raleigh, N. C., suggest these five steps for higher and more profitable corn production in that State:

(1) Use an adapted hybrid or a proven local adapted variety of seed corn.

(2) Apply fertilizer at planting time according to the condition of the soil as indicated by a soil test. From 200 to 300 pounds of 6-8-6 or 7-7-7 will probably be required per acre following such heavily fertilized crops as tobacco, cotton, and truck. From 300 to 500 pounds of 5-10-10 or 6-6-12 may be required following small grains, legumes, or other lightly fertilized crops and on potash deficient soils.

(3) For a yield of 50 to 75 bushels an acre, plant enough seed to get a final stand of 7,500 plants per acre. This means having the plants 20 inches apart in rows $3\frac{1}{2}$ feet apart. For a yield of 75 to 125 bushels an acre, aim for a final stand of 10,000 plants which means having the plants about 15 inches apart in $3\frac{1}{2}$ foot rows.

(4) Control weeds but avoid late or deep cultivation because it may injure the corn roots or it may bring new weed seeds to the surface where they can germinate. The heavy shade and competition provided by thicker stands helps control weeds after the corn is $2\frac{1}{2}$ feet high.

(5) Apply side dressing when the corn is $2\frac{1}{2}$ feet high or at 6 to 8 weeks after planting. Follow local recommendations as to how much nitrogen to apply but

as a general rule 2 pounds of straight nitrogen per acre will increase average yields by about 1 bushel. In one test in North Carolina a "no-nitrogen" plot yielded 19.1 bushels as compared with 120.9 bushels on a plot where 180 pounds of nitrogen had been added.

As in the Mississippi experiments, the increase in net returns from using a well-balanced system of farming in North Carolina is impressive, as shown by the following tabulation:

Pounds of nitrogen per acre Av. yield from 49 experiments, 1944-48	0 28	40 53	80 71	120 81
Value of corn at $1.50	$42.00	$79.50	$106.50	$121.50
Total production costs, including fertilizer and labor	34.70	43.10	50.95	57.60
Net profit per acre	7.30	36.40	55.55	63.90
Production cost per bu.	1.24	0.81	0.72	0.71

Further details on the North Carolina study are reported in Bulletin No. 366 of the Agricultural Experiment Station, North Carolina State College, Raleigh, N. C. The work was done in cooperation with the U. S. Department of Agriculture.

AT THE IOWA AGRICULTURAL EXPERIMENT STATION:

Experiments conducted by the Iowa Experiment Station from 1942-46 show the response of corn to nitrogen and to different methods of applying it. One of these tests was conducted on Salix silt loam in Woodbury County in which increasing amounts of nitrogen were broadcast on cornstalk land before listing. All plots in the study were given a blanket application of 150 pounds of 20 percent superphosphate in the lister furrow. The yield on the check plots averaged 57.7 bushels an acre; the increases in yield from 40, 80, and 120 pounds of nitrogen per acre were 9.7, 15.1, and 11.6 bushels, respectively.

Other work at the Iowa station shows the effect of different methods of applying nitrogen. The following tabulation indicates the results of applying 40 pounds of nitrogen per acre on Tama silt loam in Warren County:

Method of application	Bushels per acre
Check plot (no nitrogen)	71.2
Plow sole	81.4
Broadcast and plowed under	79.7
Broadcast after plowing	79.8
Early side dressing	80.7
Late side dressing	87.8

On all plots in the above experiments, a basic application of 200 pounds of 0-20-20 had been applied per acre.

It is recognized, of course, that crop rotations alone, but preferably with applications of manure and lime, when and as needed, may be adequate for high corn yields on the better lands of the Corn Belt. At the University of Illinois field at Aledo, for instance, a rotation system including corn, small grain, and various legumes, produced an average of 79.5 bushels of corn an acre for 31 crops when manure and lime were added. The last four corn crops of the series averaged 105.3 bushels an acre with crop residues and lime the sole treatment applied to the land.